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Claims

[c1] A flue gas scrubbing apparatus for removing NOx gases from a flue gas, the flue gas scrubbing apparatus comprising:
means for contacting the flue gas with a scrubbing medium so that the scrubbing medium absorbs acidic gases from the flue gas to produce an acidic gas-containing solution and an intermediate flue gas;
means for reducing the temperature of the intermediate flue gas to convert nitric oxide to nitrogen dioxide;
means for absorbing the nitrogen dioxide from the intermediate flue gas to produce a nitrogen dioxide-containing solution and a scrubbed flue gas; and
means for reacting the nitrogen dioxide in the nitrogen dioxide-containing solution with ammonium hydroxide to produce ammonium nitrate.

[c2] A flue gas scrubbing apparatus according to claim 15, wherein the absorbing means comprises means for contacting the intermediate flue gas with a water-containing solution so that the water-containing solution absorbs the nitrogen dioxide from the intermediate flue gas to form the nitrogen dioxide-containing solution.

[c3] A flue gas scrubbing apparatus according to claim 16, wherein the reacting means comprises means for contacting the nitrogen dioxide-containing solution with an ammonia-containing solution containing the ammonium hydroxide.

[c4] A flue gas scrubbing apparatus according to claim 16, wherein the scrubbing medium is an ammonium sulfate-containing solution containing ammonium hydroxide, and wherein the reacting means comprises means for contacting the nitrogen dioxide-containing solution with the ammonium sulfate-containing solution.

[c5] A flue gas scrubbing apparatus according to claim 15, wherein the absorbing means comprises means for contacting the intermediate flue gas with an ammonia-containing solution so that the ammonia-containing solution absorbs the nitrogen dioxide from the intermediate flue gas to produce the nitrogen dioxide-containing solution.

[c6] A flue gas scrubbing apparatus according to claim 15, wherein the scrubbing medium is an ammonium sulfate-containing solution.

[c7] A flue gas scrubbing apparatus according to claim 20, wherein the absorbing means comprises means for con-

tacting the intermediate flue gas with the ammonium sulfate-containing solution so that the ammonium sulfate-containing solution absorbs the nitrogen dioxide from the intermediate flue gas to produce the nitrogen dioxide-containing solution.

[c8] A flue gas scrubbing apparatus according to claim 15, further comprising a vessel in which the acidic gas-containing solution is accumulated, and means for introducing ammonia and oxygen into the vessel to react the acidic gases in the acidic gas-containing solution to produce ammonium sulfate.

[c9] A flue gas scrubbing apparatus according to claim 22, wherein the nitrogen dioxide-containing solution is accumulated in the vessel, where the ammonia introduced into the vessel forms the ammonium hydroxide that reacts with the nitrogen dioxide in the nitrogen dioxide-containing solution to produce ammonium nitrate.

[c10] A flue gas scrubbing apparatus according to claim 15, further comprising means for releasing the scrubbed flue gas to atmosphere.

[c11] A flue gas scrubbing apparatus for removing nitric oxide gas and acidic gases from a flue gas, the flue gas scrubbing apparatus comprising:

means for contacting the flue gas with an ammonium sulfate-containing scrubbing solution so that the scrubbing solution absorbs acidic gases from the flue gas to produce an acidic gas-containing solution and an intermediate flue gas;

a vessel containing the ammonium sulfate-containing scrubbing solution and in which the acidic gas-containing solution is accumulated;

means for reducing the temperature of the intermediate flue gas to convert nitric oxide within the intermediate flue gas to nitrogen dioxide;

means for contacting the intermediate flue gas with a water-containing scrubbing solution so that the water-containing scrubbing solution absorbs the nitrogen dioxide from the intermediate flue gas to produce a nitrogen dioxide-containing solution and a scrubbed flue gas;

means for releasing the scrubbed flue gas to atmosphere;

means for accumulating the nitrogen dioxide-containing solution in the vessel containing the ammonium sulfate-containing scrubbing solution; and

means for introducing ammonia and oxygen into the vessel to react the acidic gases in the acidic gas-containing solution to produce ammonium sulfate and to react the nitrogen dioxide in the nitrogen dioxide-

containing solution to produce ammonium nitrate.

[c12] A flue gas scrubbing apparatus according to claim 25, further comprising means for contacting the intermediate flue gas with the ammonium sulfate-containing scrubbing solution, such that the nitrogen dioxide-containing solution also contains ammonium sulfate.

[c13] A flue gas scrubbing apparatus according to claim 25, wherein the water-containing scrubbing solution used in the step of contacting the intermediate flue gas comprises the ammonium sulfate-containing scrubbing solution, such that the nitrogen dioxide-containing solution contains ammonium sulfate and water.

[c14] A flue gas scrubbing apparatus according to claim 25, further comprising means for withdrawing a portion of the ammonium sulfate-containing scrubbing solution from vessel, and means for dewatering the portion of the ammonium sulfate-containing scrubbing solution to precipitate ammonium sulfate and ammonium nitrate.